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SALUTE GUN DESIGN BUREAU'S SPACE FLIGHT PROGRAM

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SALUTE GUN DESIGN BUREAU'S SPACE FLIGHT PROGRAM

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The Salute Gun design bureau was established in March 1951. At that time, it was composed of an aircraft manufacturing plant specializing in the production of heavy bombers which produced 3M(M4) model long range bombers which are still in use even today as well as the first M50 model supersonic bombers. In 1960, the factory was reorganized to be a space rocket design bureau. In the 1960's and 1970's, it built the Proton delivery rockets (which have already been fired over 200 times). In conjunction with that, it began producing 20 ton heavy model space craft. In the 1970's and 1980's, it independently or together in combined production groups with Energy scientific research, manufactured, and, in conjunction with that, launched Salute Gun space stations, the Peace orbital station, the Cosmos series satellites (Cosmos 929, Cosmos 1267, Cosmos 1443, Cosmos 1682, and so on), as well as the Quantum, Quantum 2, the Crystal, and other similar science modules. At the present time, they are preparing to produce the Spectrum and Nature modules. In the period 1986- 1987, it built the first space craft with a weight reaching 100 tons--the Polar Region. On 15 May 1987, it carried out the first launch using an Energy delivery rocket. The mission scope of the Salute Gun design bureau is very broad. It manufactures various models of delivery rockets used as booster stages to send space craft into deep space, freighter ships and orbital stations, returnable type space craft and resealable modules, etc. (* The Polar Region space craft has a length of 37 meters. The diameter is 4.1 meters. The mass is close to 40 tons. It is composed from two modular sections--the main modules and the auxiliary modules. 4 main engines, 20 direction and attitude stabilizing engines,

* Numbers in margins indicate foreign pagination. Commas in numbers indicate decimals.

and other auxiliary systems are mounted in the propulsion system module. On 15 May 1987, after the Polar Region space craft was launched into space from the Baikenuer (phonetic) launch site using an Energy rocket, due to control system malfunction, it fell into the South Pacific. Despite the fact that the launch failed, a wealth of experimental data was still obtained, however. These data demonstrated at least three points: 1. Super heavy models of lifting rockets and useful loads equipped with asymmetrical side fins are capable of operating together; 2. The preparation and launch sequence for the Energy lifting rocket is correct; 3. It is the beginning of testing 100 ton class space platforms.)

The Salute Gun design bureau, among the entirety of independent federated space flight industries, sought the "position" it should have for its own space flight activities. As a result, it developed several types of design plans. These plans will constitute a few "tiles" on the great mansion of the brilliant future of Russia's space flight enterprises.

I. SPACE PRODUCTION

As far as space production goes, in accordance with its special characteristics, it refers to space production tests. These tests are very close to the era of space factories, that is, the organization, in a cosmic space environment, of the production of new types of materials. At the present time, this type of experiment is carried out on the Photon autonomous space craft and the Peace orbital station. As the specialized equipment used in making small batches of new space research materials and experimental

production, there is Nika-T (phonetic).

Comparing material samples obtained up to now and samples produced on the ground, performance is much better. However, no matter what type of material it is, the economic rationality of producing it in space has still not been finally demonstrated. Besides the huge expenses of taking raw materials and sending them into space and then taking finished goods and shipping them back to the ground, the imperfection of space production equipment currently on hand and of industrial processes are also important reasons for costs being high and not coming down.

In order to successfully carry out the production of space materials, it is necessary to satisfy the requirements discussed below: space factors (weightlessness, vacuum), industrial process requirements (minimum transshipment, strong energy sources, long processes), equipment capabilities.

Research personnel associated with the realms of materials science, biotechnology, and fluid physics put forward very strict requirements on weightless masses. Actual zero gravity on space craft is determined by a number of natural and artificial factors.

Ideal conditions of weightlessness only exists at those points where the center of mass of the space craft is congruent with the orbit, and is reached only then. Any deviation of the center of gravity will give rise in all cases to a gravity gradient, thus increasing the deviation from the center of mass orbit. In reality, this simply means that it is necessary to take all the industrial equipment and put it at the center of mass position of the space craft. However, this is not possible to realize.

Several other natural factors influencing weightless conditions are: space craft rotation around center of mass, restraints from the earth's residual atmosphere, as well as other factors. However, even less beneficial factors are various space craft systems--in particular, periodic and sudden perturbations coming from the flight crew.

From this, one comes to the conclusion that in order to guarantee space craft having optimum weightless conditions so as to carry out space production, use will be made of an automated platform flying free. In this way, the space craft is capable of guaranteeing that the acceleration of gravity does not exceed 10- 5 - 10-6 g.

Producing microelectronics materials is very difficult. For this, one needs power sources of several tens of thousands of watts. Moreover, there are times when production processes must continue for several months. It is only under conditions with these types of large powers that it is then possible to obtain high quality samples with the needed diameters (100 millimeters or more). The Peace orbital station's average electric power source is 3-4 thousand watts (the U.S. space shuttle is 7 thousand watts).

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Different materials require their refining systems to have different technological periods. The times industrial processes continue go from a few hours to several months, and so on. Within the interval periods between these cycles, space craft orbital corrections are carried out, solar energy cells directed, as well as other propulsion correction work.

On space craft, there should be means to send samples back to earth. These can be specialized ballistic type sealed return

modules which have already been developed. Materials are perfectly preserved with sealed modules. It is necessary to guarantee this through sealed module braking and landing techniques. As far as the periods when materials are sealed in modules are concerned, it is also necessary to maintain certain temperature and humidity states. Due to the fact that there are no human operators in space factories, taking produced materials and loading them into sealed modules, and, in conjunction with that, taking them and throwing them out, is all carried out automatically.

Finally, space factories in orbit must operate 5-10 years. Within this long a period, maintaining good operating states is not only required of industrial equipment but also required of space craft systems themselves. If one wants to get to this point, it is necessary to use a type of visiting space craft to send crew personnel to the space factory to stay for short periods in order to carry out maintenance and repair work in the plant. This then means that it is necessary in space factories to set up systems for docking with transport ships and living systems for crew personnel.

II. 100 TON CLASS SPACE CRAFT

Analysis of the requirements discussed above clearly shows that it is necessary to satisfy these requirements. It is necessary to build long life (--10years), heavy (--100 tons), automated space craft which can be visited. In conjunction with this, they are equipped with strong energy sources (--60 thousand watts).

This type of space craft plan has already been designed. It is called the Industrial Production Module (see Fig.1).

The take off mass is 101.9 tons. In orbit, the mass is 88 tons. Industrial equipment and consumption materials have a total weight of 25 tons. Operating time is 5 years. Electric power sources are 5-12 thousand watts at 28.5 volts and 26-57 thousand watts at 115 volts. Orbit altitude is 380-400 km. Orbital inclination angle is 51.6°. Operating configuration is automatic. Crew personnel visit 1-2 times each year. Industrial equipment area microgravity is 10-5 - 10-6 g.

This 100 ton space craft can use Energy lifting rockets for launch. Due to the Energy itself certainly not being able to take the useful load and send it into operational orbit, the only thing to do is, therefore, to use the propulsion systems of the industrial production module itself in order to finish. This plan has already gone through drills. In conjunction with this, on 15 May 1987, during the process of the Energy lifting rocket launching a Polar Region space craft for the first time, verification was achieved. Experience manufacturing the Polar Region also laid the foundation for designing the industrial production module.

It is only when one has this type of large model space craft--such as the industrial production module--that it is then possible to realize the various types of requirements presented by space factories. It is projected that production equipment will include volcanic crater type thermal electric furnaces. These have already gone through testing on the Peace orbital station.

In order to make a certain number of pieces of industrial equipment capable of operating at the same time, on the ship, high efficiency power supply equipment is installed (115 volts).

The foundation is solar energy cell panels with a total area reaching 500 m2 . The average power is 35 thousand watts (design power 60 thousand watts).

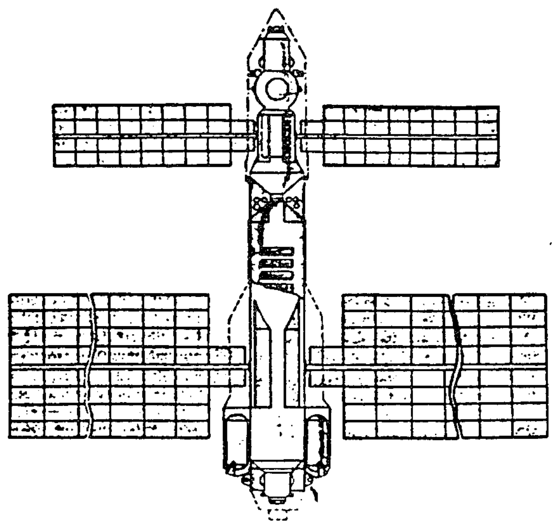

Fig.1 Industrial Production Module Schematic

Industrial equipment is installed in the area of the center of mass of the space craft. The large dimensions of space factories (40 meters long) are capable of eliminating sources of vibratory interference coming from industrial equipment. Due to operations in production periods being automated, during smelting processes, people are, therefore, able not to be on the space craft. In this way, it is then possible to eliminate the most important source of vibrations influencing industrial processes. Combining selections of correct directions and propulsion forces, measures adopted for system operating configurations are capable of guaranteeing that--during production processes--ranges of acceleration on the station are within 10-5 - 10-6 g. This is adequate to be able to guarantee

high quality in the materials obtained.

Completed products will use returnable type ballistic sealed modules or gliding type sealed modules to return to the ground. Each sealed module is capable of containing 140kg of material. Module loading of material will be carried out automatically using the mechanical hands on the space craft. In the second part, mechanical hands will take sealed modules from specially made transport frames and move them to the air lock chamber. From here, they will be thrown out toward the earth. In dense atmosphere, they will aerodynamically stabilize. In conjunction with this, parachutes will be used to soften their fall and landing.

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Space flight personnel can work for ten days and nights on the industrial production module. Taking space flight personnel, consumption materials, and spare equipment into orbit is done by the already existing Union ships and the multiuse aviation space flight system (MAKC) orbital aircraft. The latter plan has /14 already been designed out by the Lightning scientific research and production consortium. MAKC are composed of a booster stage, an orbital aircraft (second stage), and the AH-255 "Мрия" delivery aircraft which is already on hand (acting as a first stage).

In this way, space factories can produce 1-2 tons of material each year.

All preparatory work to realize this plan is currently ready because the foundation components are already mature. Manufacturing this type of factory requires 6-7 years.

III. 20 TON CLASS SPACE CRAFT

At the present time, if one wants to obtain high quality electronic, laser, and infrared instruments, it is then necessary to have high quality new materials. New materials include: germanium, silicon, gallium arsenide, zinc oxide, cadmium sulfide, cadmium telluride, mercury disulphonide, manganese-mercury-tellurium alloy, and so on.

Space factories can also prepare planar optical glass for the optics industry, and there is no way to produce this type of optical glass on the ground.

In the realm of biotechnology, under weightless conditions, it is possible to prepare protein crystals. Moreover, equipment for pharmaceutical use can obtain large amounts of highly effective pharmaceutical used in the treatment of diabetes, cancer, anemia, and poor infantile development, as well as other diseases.

These materials have not yet gone on the market. However, their price quotations have still changed very greatly. Seen as of today, these materials must be produced. However, tomorrow, the situation changes. As a result, the range of price changes for products produced is very great.

Because of this, in order to obtain economic benefits, it is necessary in space factories to produce various different types of materials in accordance with flexible production plans in order to obtain maximum profit. However, shrewd calculations clearly show that the expenditures for space factories operating

for periods of 5 years will gain huge profits--at least double or using the income from the sale of the materials offset the entire consumption (This still includes the costs of biological agents. Their prices change very greatly.)

The realization of this plan requires having consumers. Only when there are consumers are there people to put in funds. Conscious of the complexity of the problem of funding, the Salute Gun design bureau put forward the plan discussed below for a gradual development of space production.

First, make use of active duty rockets retired on the basis of U.S.-Soviet treaties on the reduction of strategic weapons in order to complete space working industrial processes. After taking combat components out, it is possible to load a one or two ton space craft. Even if it cannot be lifted into too high an orbit, and times are not too long (45 minutes to 6 hours), they are still capable of creating conditions required for biotechnology. Within this time period, it is possible to get 50 grams of high quality biological material, using recoverable sealed modules to send it back to the ground. This plan is both simple and economical. It can be realized in 1993-1994.

Second, build a type of 20 ton autonomous space craft. Use a Proton rocket to send it into a 500km high orbit. The operating period will be 5 years. Out of a total space craft weight of 20 tons, there will be approximately 10 tons which can be used in order to carry out various types of scientific research and experimental work. Dealing with pharmaceutical and biological agents--in particular, pure substances--certain materials used by the photoelectronics industry are produced semiindustrially.

The Salute Gun design bureau has set out two types of plans for this kind of space craft. The industrial arts space craft

and the orbiting pharmacist space craft.

There is already a prototype for the industrial arts space craft--that is, the Crystal module which is currently working together with the Peace orbital station. As far as the problem of returning products and technological equipment to the earth is concerned, it is planned to make use of reusable small model and large model returnable type sealed modules to resolve it. The orbiting pharmacist space craft, by contrast, is built in accordance with other principles. It is a returnable type space craft. The advantage is that it can be used multiple times (approximately 10 times). The space craft and industrial equipment go through refits and the loading of raw materials on the ground and are sent back into space once again.

With regard to the building of this type of 20 ton class space craft, the costs are equivalent to the costs of the crystal module in the process of operating in space at the present time.

The Salute Gun design bureau put forward a type of tellurium- эко industrial space craft plan seen in Fig.3.

The mass of this type of industrial space craft is 20 tons. The mass of useful load is 10 tons. The uninterrupted electric power supply is 5 thousand watts. Orbital altitude is 400-450km. Orbital angles of inclination are 52°, 65°, and 72°. Space craft are equipped with multiple use, multiple frequency laser radar systems. The characteristics are as follows: radiated wave lengths are 10.6, 1.06, 0.76, and 0.3-0.5 microns; pulse energies are 1-10 joules; pulse lengths are 0.01-1.0 micro seconds; maximum pulse frequency 50 Hz; scanning angle is 50°; field of view, observation configuration 800x9000km, forward course detection configuration 800x100km.

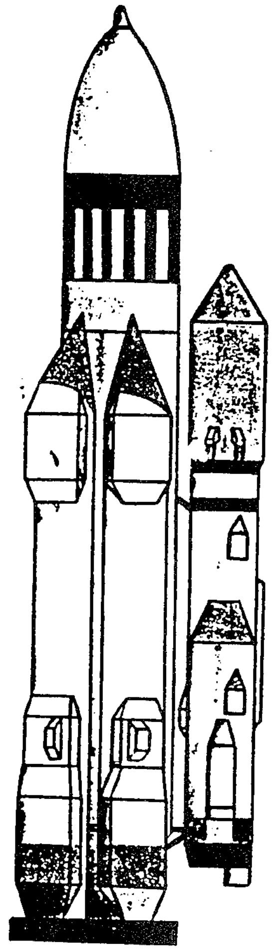

Fig.2 Industrial Production Module Fixed to a Delivery Rocket

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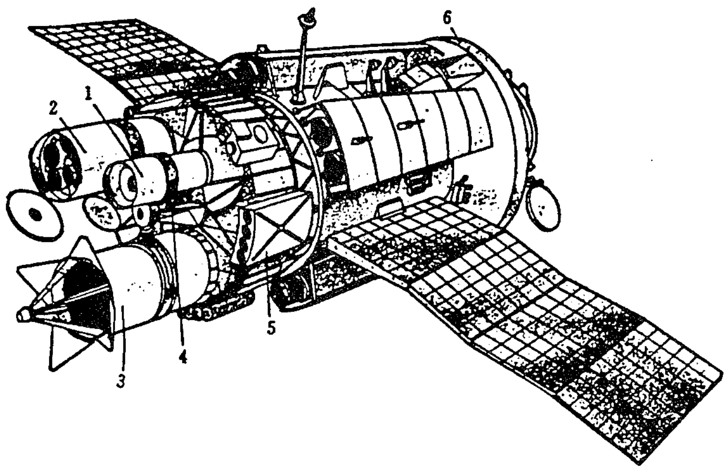

Fig.3 Tellurium- Industrial Space Craft 1. Television Equipment System 2. Optical Spectra and Radio Measurement Instrumentation System 3. Support-Rotation Platform 4. Multiple Radar Frequency System 5. Separable Artificial Electric Power Source Capacitor Combination 6. Standard Space Platform

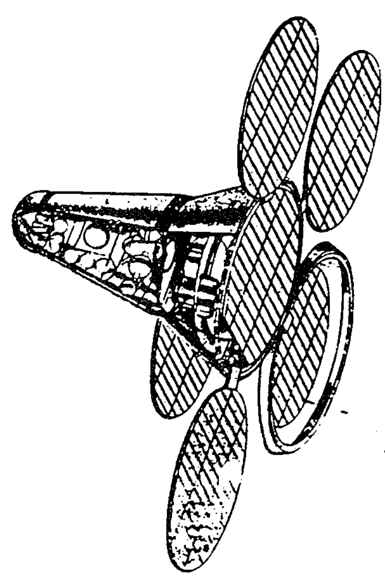

Fig.4 Orbital Pharmacist Space Craft

The orbital pharmacist space craft (see Fig.4) must be a bit complicated. It requires having a large model spaceship return from orbit. However, the results from using it are relatively good and flexible.

The mass of this type of space craft in orbit is 20 tons. The mass of industrial equipment is 2 tons. Orbital altitude is 400-450km. Orbital angle of inclination is 51.6°. Electrical power is 5-12 thousand watts. Each flight period is one year. It can be reused 10 times. The amount produced in each flight is 600kg.

As far as manufacturing this sort of returnable type space craft is concerned, under ideal conditions, it still requires 4-5 years. Moreover, there is a need to have them stored up in reserve. Because of this, the following several plans below have been made.

1. As far as the currently available Photon space craft is concerned, the operating time is two weeks. It is capable of sending back a production of 60kg. If it has added to it 1.2ton short term (6 hour) operating equipment, it is capable of returning to the ground a product which can reach 100kg.

2. After that, there is a possibility of manufacturing Nika(phonetic)-T space craft. Their characteristics are relatively liberal. Operating time is 6 months. Load carrying capacity is 2 tons. Electrical power sources are approximately 5 thousand watts. The product returned to the ground is 1200kg.

3. On the Peace orbital station which is currently in flight, development continues on methods to acquire new materials--in particular, industrial process equipment.

4. As far as the new 20 ton Class I space craft composed of industrial space craft and orbital pharmacist space craft are concerned, flight times are long (5 years). Electrical power source equipment is large (9 thousand watts). Vibration overloads are small. This constitutes an entirely new production capability. In it, it is possible to do tests of different combinations of industrial equipment and materials in order to master test production.

5. Finally, space factories will possess automated equipment which has already gone through testing and a semiindustrialized production scale.

Besides projects which have already been discussed above and listed in plans, the Salute Gun design bureau has also drawn up another plan on the foundation of the "20 Ton Project".

That is, a new type of tool which can come from changes to the principles of the multiple use tellurium- space craft to use in comprehensive research as well as monitoring the environment of the earth's surface, and the status of the near earth environment as well as the near earth space environment. First of all, utilization is made of the multiple use, multiple frequency laser radar systems on space craft to carry out telemetry of the earth. It uses a Proton lifting rocket for launch into operating orbit. This type of space craft is capable of construction before 1995. In conjunction with this, utilization is for 5 years.

This type of space craft is developed on the foundation of the 20 ton space craft which the Salute Gun design bureau manufactured and successfully operated in the past. Taking it as the foundation principle, they are capable of manufacturing space craft for various types of different uses. They include two basic sections--specialized modules which carry equipment for completing scientific research and production missions, and

common use modules which are, in fact, a kind of standardized space platform. In the specialized locations, it is possible to install 6 tons or less of mission type useful load.

(Zhang Wanzhou Supplied Manuscript)

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